



The Global Precipitation Climatology Project (GPCP) CDR

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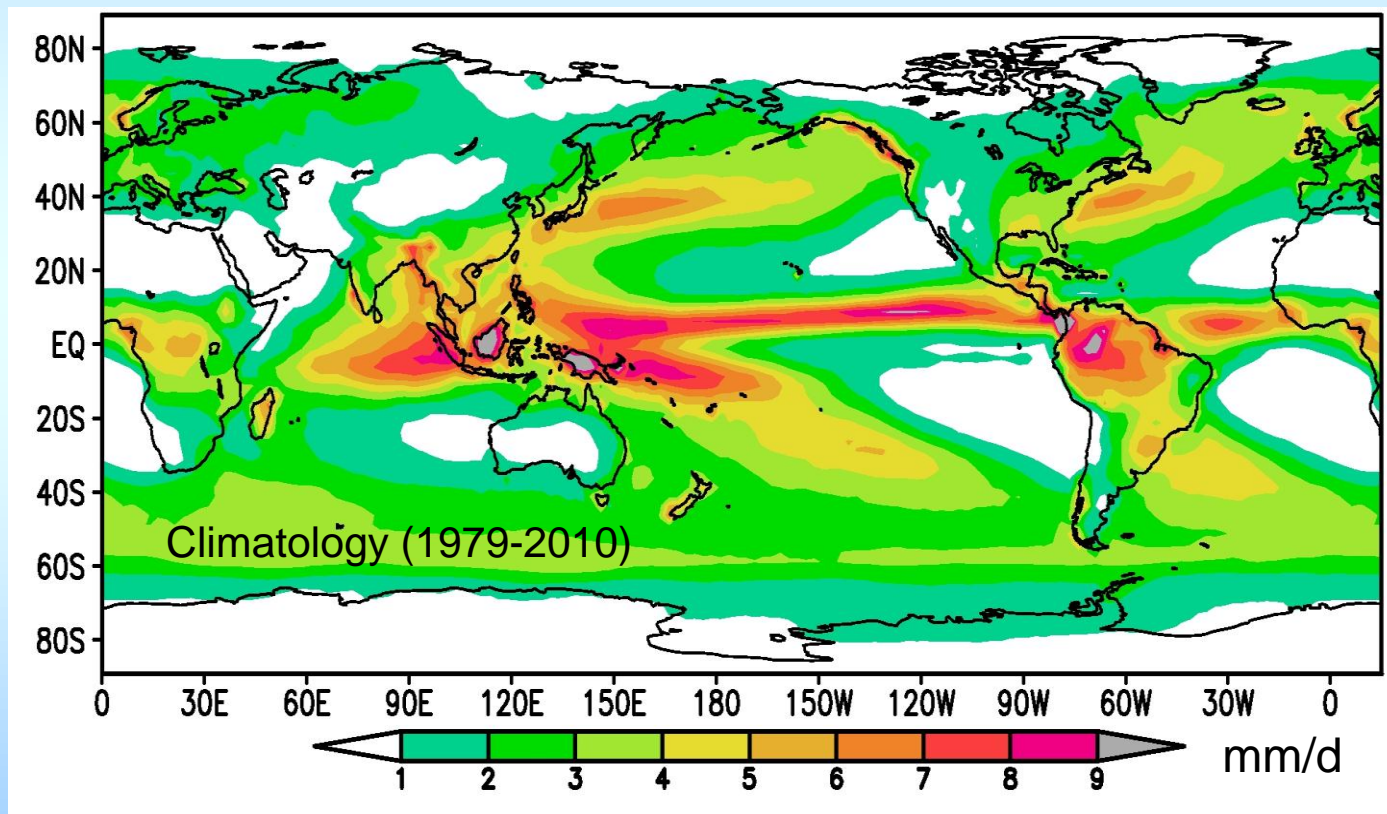
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**Matt Sapiano (UMD) and George Huffman (NASA
Goddard and SSAI)**

Project Description

Global Precipitation Climatology Project (GPCP)

GPCP is an international, inter-agency effort under auspices of GEWEX/WCRP to provide global precipitation analyses at monthly and finer time scales.



GPCP data used in > 1500 journal articles

GPCP Global Precipitation Products

Current Version (2.2)

- Monthly, 2.5° Merged Analysis (1979-present)

Adler et al. (2003), J. Hydromet.

Huffman et al. (2009) GRL

- Pentad, 2.5° Merged Analysis (1979-present)

Xie et al. (2003) J. Climate

- Daily, 1° Merged Analysis (1997-present)

Huffman et al. (2001) J. Hydromet.

*[although produced using different data sets and algorithms,
products are integrated, i.e. they add up]*

normally produced ~ 2 months after observation time

GPCP Components / People

R. Adler (GPCP Coordinator)

- *Merge Center--Huffman/Adler, NASA Goddard/U. of Maryland (TOVS/AIRS data from Susskind, Goddard)*
- *Gauge Center—Becker, Schneider, German Weather Service, Global Precipitation Climatology Center (GPCC)*
- *Microwave-Land Center--Ferraro, NOAA NESDIS*
- *Microwave-Ocean Center--Chiu, George Mason U.*
- *Geosynchronous Center--Xie, NOAA/NWS/CPC (also does pentad merge)*

Underlined Names are CO-I's on this CDR project

GPCP Plans for Future

- As part of GEWEX re-processing of all global water/energy data sets (e.g., ISCCP, SeaFlux), GPCP group trying to develop next version (Version 3) of GPCP
 - New input data sets (e.g., TRMM, AMSR), higher time and space resolutions (down to 3-hr and 25 km for part of period).
 - Probable link to NASA/NOAA GPM activities
 - New groups (e.g., CSU, UCI) involved
 - Rain/snow discrimination (by temperature)
 - Development/implementation is resource limited at this point
- “Real-time” monthly GPCP (V2) for climate monitoring using the pertinent data sets (some in preliminary form) within ~10 days of end of month

NOAA CDR Project--GPCP

The current GPCP monthly (1979-present), pentad (1979-present) and daily products (1997-present) have been developed by research groups over the last 15 years and are produced by a consortium of those groups using significant human intervention and funded by various agencies.

NOAA CDR Objective—To successfully update, streamline and integrate the GPCP production code for “automated” production and transfer the routine production of GPCP Version 2 products to NCDC from the manually driven processing of the Co-Is.

General Approach

- 3-year effort to clean-up, streamline, test and validate software from various organizations to work in as close to an automated way as possible—current processing is step-by-step with knowledgeable people heavily involved.
- Software to be designed to meet NCDC requirements/standards as close as possible
- Some processing components will remain at home institutions (GPCC gauge analysis, input pentad precipitation analysis from NOAA/CPC).
- Some science support for GPCP scientists for dealing with issues that come up in processing, for evaluation of products and for making software changes to adjust for changes in input data.

Project Description

CDR(s) (Validated Outputs)	Period of Record	Spatial Resolution; Projection information	Time Step	Data format	Inputs	Uncertainty Estimates (in percent or error)	Collateral Products (unofficial and/or unvalidated)
GPCP V2.2 Precipitation	1979 - present	2.5 degree global grid	Monthly	NetCDF4	RSS SSMI(S) Tb; Ferraro PMW Land precip; Geo-IR precip (GPI); OPI; Susskind TOVS/AIRS; GPCC Gauge	Error estimates attached to grid; ~10%	Includes all interim products and errors
GPCP Pentad Precipitation	1979 - present	2.5 degree global grid	5-day mean	NetCDF4	NOAA CPC Pentad Precipitation (CMAP); GPCP V2.2 Monthly	~10%	-----
GPCP 1- degree Daily Precipitation	1997 - present	1 degree global grid	Daily	NetCDF4	GPROF SSMI; GPCP V2.2 Monthly	~20%	-----

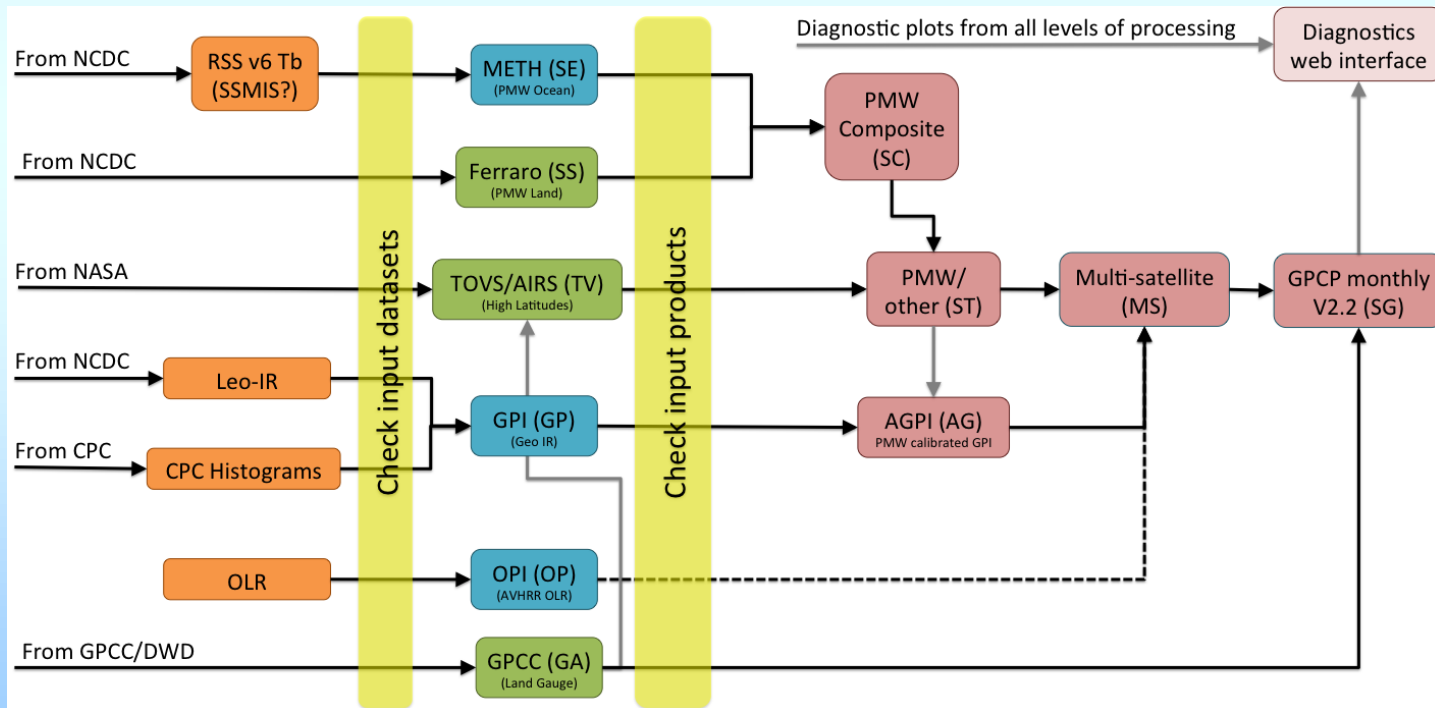
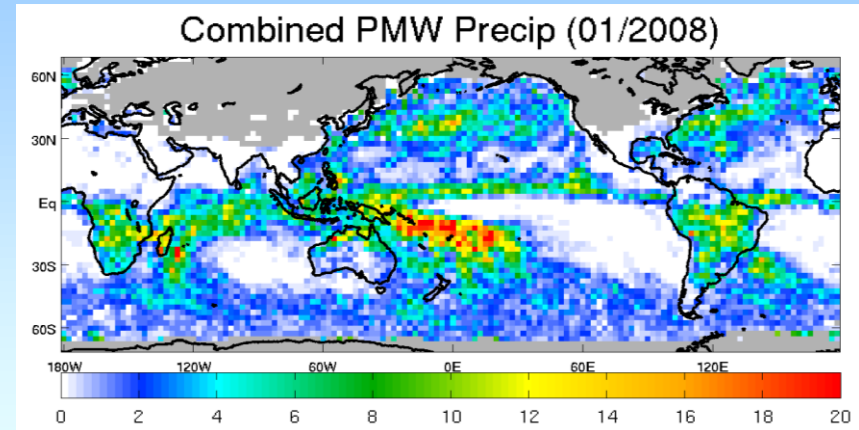
Production Approach (1)

- Three separate code elements: monthly, pentad, 1-deg daily
 - All current code is “legacy” and requires significant human intervention
 - All CDR code will be automated (including diagnostics) and run by the Executive Control Package (ECP)

Acquisition codes	Executive Control Package (for operational and reprocessing)			
Dataset acquisition codes (cron jobs)	Part A: Input file checking	Part B: Process algorithms	Part C: Merge part precip products	Part D: Examine diagnostics
RSS Tb (NCDC) Ferraro (NCDC) TOVS/AIRS (NASA) GridSat B1 (NCDC) GPCC (DWD) CMAP Pentad	RSS Tb, Ferraro, TOVS/AIRS, LEO-IR, CPC histograms, GPCC, OLR Check all required files exist and are valid	METH, GPI, OPI Ingest files, run algorithms, QC outputs, produce diagnostics, produce part B precip estimates	METH, Ferraro, TOVS/AIRS, GPI, OPI, GPCC, CMAP Pentad Ingest files, QC (SD check), combine to produce V2.2, create diagnostics	Webpage with maps of each interim/final product and timeseries Check plots of diagnostics, re-run if needed

Production Approach (2)

- The ECP runs algorithms, combines precipitation estimates and produces diagnostics
- Figure shows PMW-only precipitation for Jan08 from ECP code



Quality Assurance Approach

- Input and intermediate file checks
 - Check the file sizes of the externally-provided data to ensure the integrity of the data transfer
 - Check the files sizes of all intermediate and output data to ensure nominal module completion
 - Examine the output log for standard format error and warning messages from each module (all modules will have a common error/warning reporting syntax)
- Delivered package will include code to produce diagnostic information for delivery to expert group via web
 - Will include plots of the output precipitation fields for each input, intermediate and final satellite-gauge precipitation and precipitation error products
 - Generate monthly ocean, land and total precipitation anomaly time series from the start of the record to assure expected behavior
 - Where applicable, we will codify the current manual QA approach for inclusion in diagnostic package (eg sigma checks to ensure products are reasonable)

Applications

With over 1500 journal articles using GPCP data there has been extensive application of the information over a wide range of subjects--an examination of about the last year or so of available compilation indicates the following examples subject-wise:

Climate Analysis: “Global Climate, Precipitation, in State of the Climate in 2011”. Parker et al., BAMS, 2012 [NOAA/NCDC]

“Drought under global warming: a review” Dai
WILEY INTERDISCIPLINARY REVIEWS-CLIMATE CHANGE Volume: 2, 2011.

Global model validation: “MERRA: NASA's Modern-Era Retrospective Analysis for Research and Applications” , Michele Rienecker et al. JOURNAL OF CLIMATE 3624-3648, 2011.

“An Evaluation of Rainfall Frequency and Intensity over the Australian Region in a Global Climate Model” Brown et al., JOURNAL OF CLIMATE 2010

Climate Forecasts:” Challenges for Integrating Seasonal Climate Forecasts in User Applications” Coelho et al., CURRENT OPINION IN ENVIRONMENTAL SUSTAINABILITY 2010.

Applications (cont.)

Government and economics: “Rain and the Democratic Window of Opportunity”. Brueckner and Ciccone *ECONOMETRICA*, 2011.

“Economic Shocks and Civil Conflict: An Instrumental Variables Approach”, Miguel et al., *JOURNAL OF POLITICAL ECONOMY*, 2004

Health: “Early Warnings of the Potential for Malaria Transmission in Rural Africa” Yamana and Eltahir, *MALARIA JOURNAL*, 2010

Agriculture: “Analysis of Vegetation Response to Rainfall with Satellite Images”, Jiang et al., *JOURNAL OF GEOGRAPHICAL SCIENCES*, 2011

Hydrology: “Floods over the Midwest: A Regional Water Cycle Perspective” Dirmeyer and Kinter, *JOURNAL OF HYDROMETEOROLOGY*, 2010

Oceans: “Impact of Bathythermograph Temperature Bias Models on an Ocean Reanalysis” Giese et al., *JOURNAL OF CLIMATE*, 2011

Arctic and Antarctic: “Importance of Deposition Processes in Simulating the Seasonality of the Arctic Black Carbon Aerosol” Huang et al., *JOURNAL OF GEOPHYSICAL RESEARCH-ATMOSPHERES* 2010.

Upper Atmosphere: “Impact of Polar Ozone Depletion on Subtropical Precipitation” Kang et al., *SCIENCE* 2011.

Impact of Polar Ozone Depletion on Subtropical Precipitation

S. M. Kang,^{1*} L. M. Polvani,^{1,2} J. C. Fyfe,³ M. Sigmond⁴

Columbia U., etc. 2011

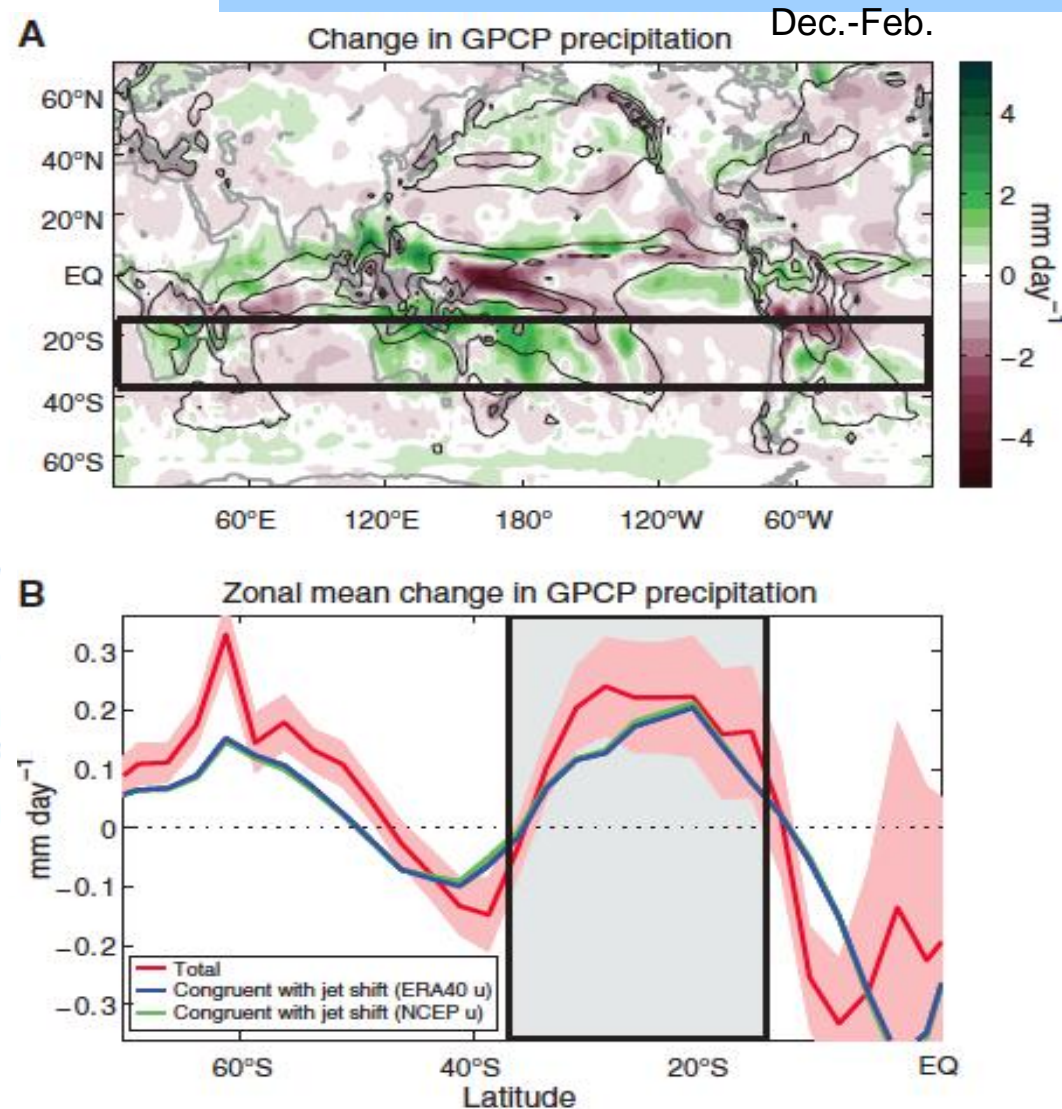


Fig. 1. Observed precipitation change between 1979 and 2000 in austral summer (December to February mean). (A) Precipitation change based on Global Precipitation Climatology Project (GPCP) data (25), calculated from the linear trend multiplied by 22 years. Black contours show the mean precipitation for 1979 to 1983, with contour interval of 3 mm day⁻¹. (B) Zonal-mean precipitation change (red line) with 95% confidence interval (red shading), and the change congruent (16) with a change in the latitude of the westerly jet obtained from ERA40 (26) (blue line) and National Centers for Environmental Prediction (NCEP)/NCAR (27) (green line) reanalysis data.

Global Changes (1988-2008)

Surface Temp.
(Amplitude $\sim .2^{\circ}\text{C}$)

Water Vapor ($\sim 7\%/^{\circ}\text{C}$
for ENSO, $\sim 6\%/^{\circ}\text{C}$ for
volcano)

Precipitation ($\sim 2\%/^{\circ}\text{C}$
for ENSO, $\sim 4\%/^{\circ}\text{C}$ for
volcano)

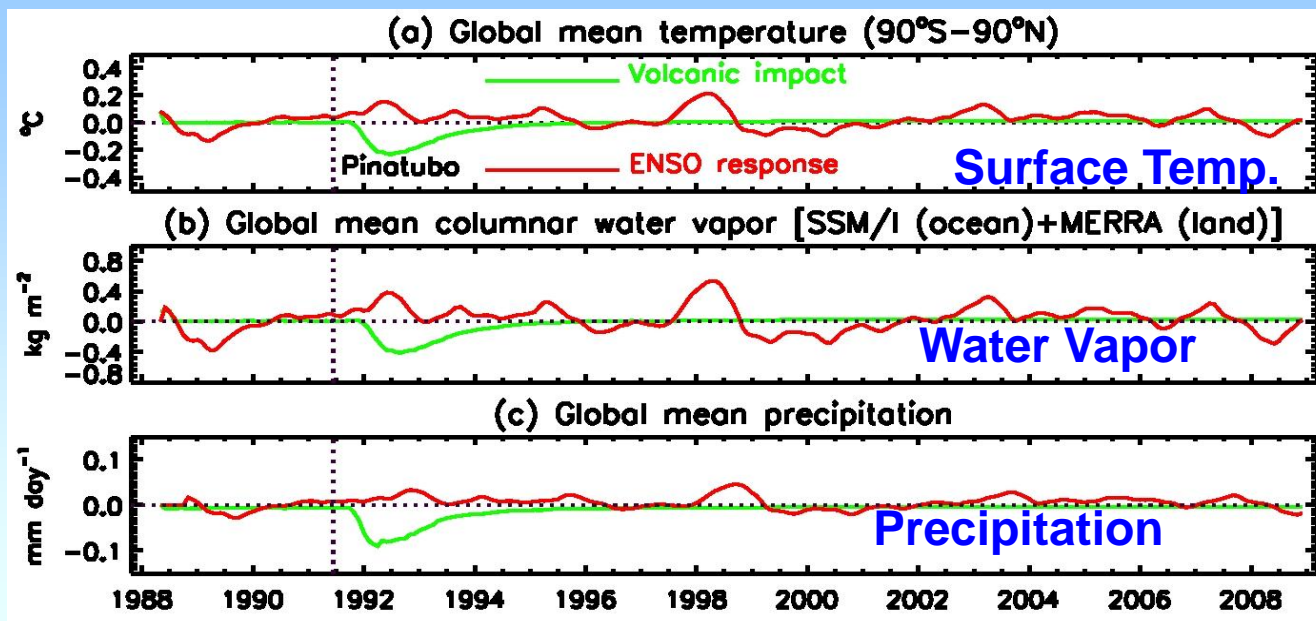
Surface Temp. (.15
 $^{\circ}\text{C}/10\text{yr}$)

Water Vapor ($\sim 7\%/^{\circ}\text{C}$,
taking into account
MERRA trend bias)

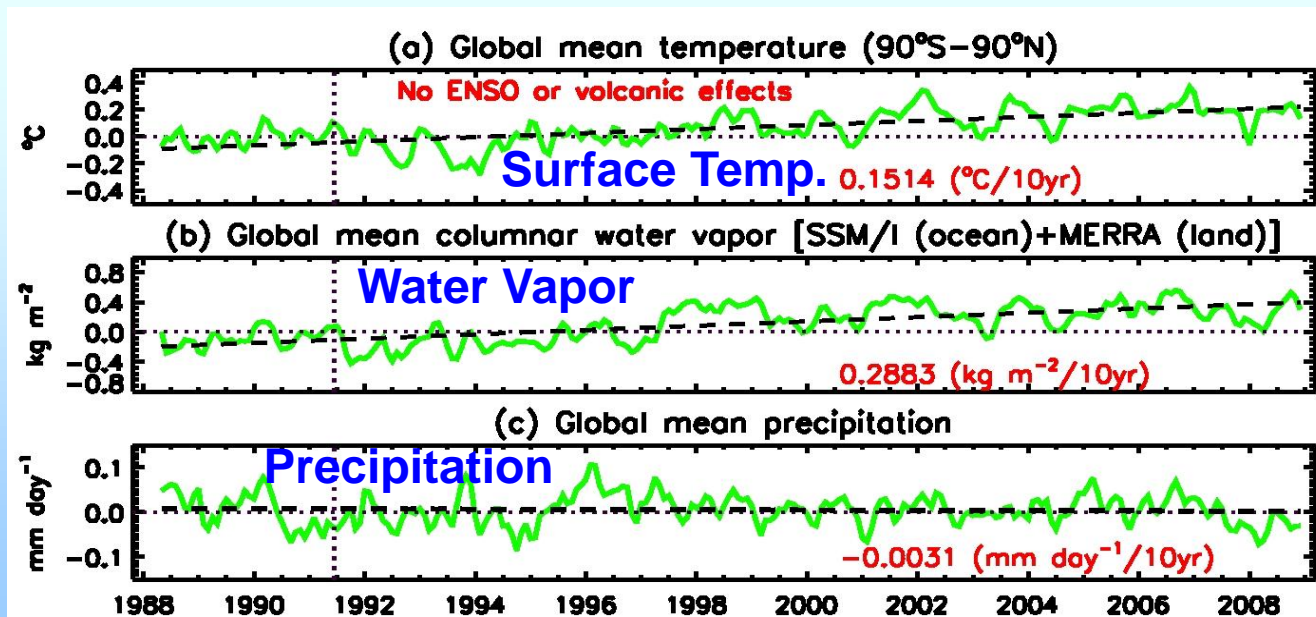
Precipitation ($\sim 0\%/^{\circ}\text{C}$)

Gu and Adler 2011 Int.J.Clim.

Inter-annual (ENSO and Volcano)



Trend



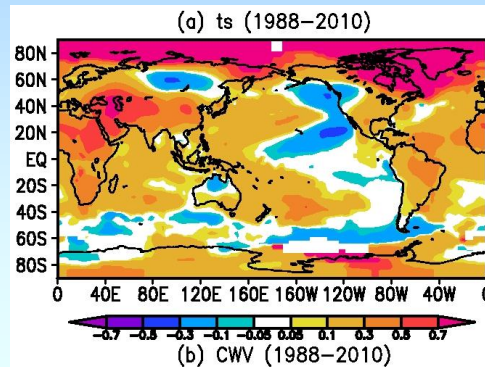
Pattern of Precipitation Trends (1988-2010) Related to Combination of Global Warming Plus Pacific Decadal Variation

Observed Changes
(linear fits)

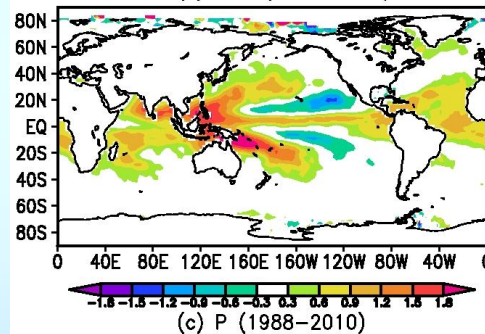
Pacific Decadal Var.

Surface Warming

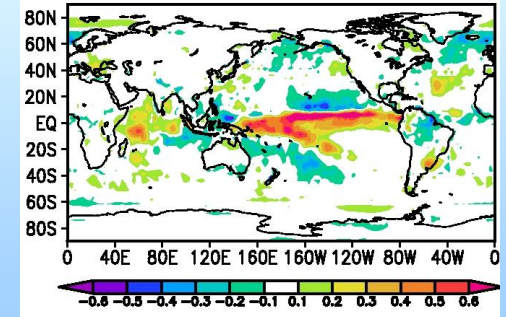
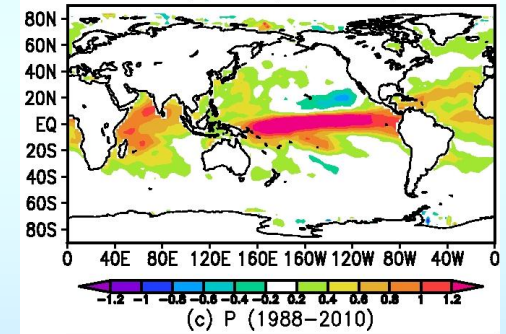
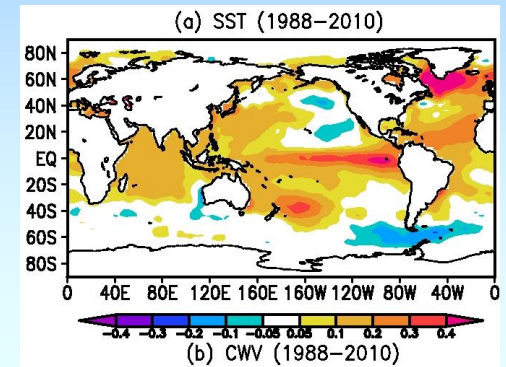
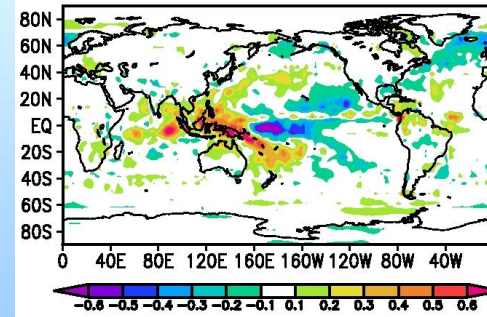
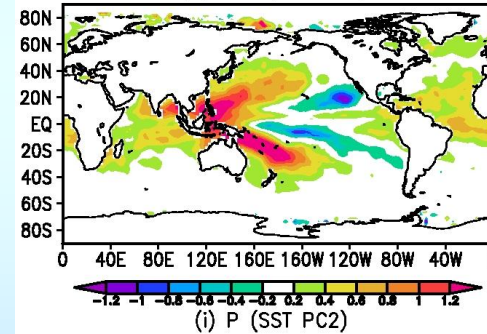
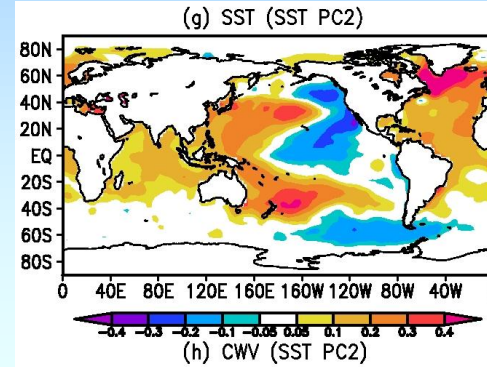
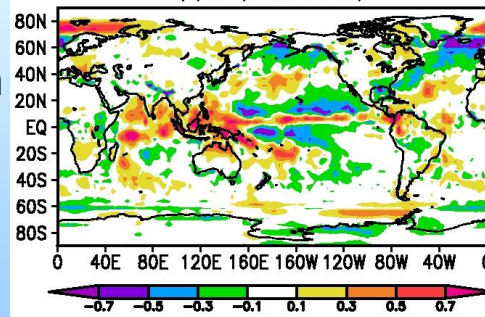
Surface
Temperature



Water Vapor



Precipitation
(GPCP)



Gu and Adler, Clim. Dynamics, 2012 (In Press)

Schedule

- **Project status: end of first year**
 - Established executive control package and related code infrastructure (netcdf4, etc.)
 - Obtained code (from GMU) to produce ocean precipitation and automated this process
 - Modified GMU code to accept RSS CDR Tb NetCDF4 files
 - Implemented PMW merger (land + ocean) algorithms
 - Started work on documentation
- **Near-term Plans**
 - Produce PMW-only precipitation from 1988 and compare with original dataset
 - Implement the rest of the monthly processing code and further streamline whole package
 - Begin implementation of pentad version

Issues

- **Input data dependency, e.g., RSS V7 Tb at NCDC – when and for how long?**
 - Other dependencies fine for now: Geo-IR precip (CPC), land precip (NCDC), high-latitude precip from AIRS (NASA), GPCC gauge data (DWD)
- **Need to better understand NCDC running environment and establish test procedures**